TABLE 1.—*Mean temperatures.*

	Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1918.													
"Sun" shelter..	17.4	34.6	50.0	50.0	69.6	78.3	77.4	82.7	62.4	60.2	41.1	36.7	55.0
"Shade" shelter...........	17.7	34.8	50.2	50.0	69.2	77.6	76.6	82.2	62.2	59.7	41.4	37.6	54.9
Difference....	−0.3	−0.2	−0.2	0.0	+0.4	+0.7	+0.8	+0.5	+0.2	+0.5	−0.3	−0.9	+0.1
1919.													
"Sun" shelter..	30.7	34.5	44.8	54.4	62.6	74.1	80.6	77.0	71.2	55.1	42.2	25.8	54.4
"Shade" shelter...........	31.2	34.6	44.8	54.0	62.2	73.2	80.0	76.4	71.0	55.2	42.6	26.1	54.3
Difference....	−0.5	−0.1	0.0	+0.4	+0.4	+0.9	+0.6	+0.6	+0.2	−0.1	−0.4	+0.3	+0.1

TABLE 2.—*Mean maximum temperatures.*

	Jan.	Feb	Mar.	Apr.	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec	Annual.
1918.													
"Sun" shelter..	29.6	49.5	66.5	62.4	81.5	91.9	90.6	96.8	76.4	72.1	48.5	46.8	67.7
"Shade" shelter...........	29.1	49.0	65.8	61.0	79.9	89.2	87.8	94.1	73.4	69.5	47.8	46.8	66.1
Difference....	+0.5	+0.5	+0.7	+1.4	+1.6	+2.7	2.8	+2.7	+3.0	+2.6	+0.7	0.0	+1.6
1919.													
"Sun" shelter..	43.8	45.5	56.8	65.2	74.1	85.3	94.5	90.7	85.1	67.7	56.5	35.4	66.7
"Shade" shelter...........	43.5	45.2	56.1	64.2	72.2	82.6	91.8	88.0	82.9	66.3	56.1	35.0	65.3
Difference....	+0.3	+0.3	+0.7	+1.0	+1.9	+2.7	+2.7	+2.7	+2.2	+1.4	+0.4	+0.4	+1.4

TABLE 3.—*Mean minimum temperatures.*

	Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1918.													
"Sun" shelter..	5.3	19.7	33.4	37.6	57.6	64.7	64.1	68.6	48.5	48.4	33.7	26.6	42.4
"Shade" shelter...........	6.3	20.7	34.6	38.2	58.6	66.0	65.4	70.3	50.5	49.9	34.9	28.4	43.6
Difference....	−1.0	−1.0	−1.2	−0.6	−1.0	−1.3	−1.3	−2.3	−2.0	−1.5	−1.2	−1.8	−1.2
1919.													
"Sun" shelter..	17.6	23.5	32.7	43.6	51.1	62.9	66.8	63.4	57.2	42.5	27.9	16.3	42.1
"Shade" shelter...........	18.9	24.0	33.4	43.9	52.2	68.8	68.3	64.7	59.1	44.1	29.2	17.2	43.2
Difference....	−1.3	−0.5	−0.7	−0.3	−1.1	−0.9	−1.5	−1.3	−1.9	−1.6	−1.3	−0.9	−1.1

TABLE 4.—*Maximum temperatures.*

	Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept	Oct.	Nov.	Dec.	Annual.
1918.													
"Sun" shelter..	52	78	85	80	92	106	104	109	92	92	72	69	[1] 109
"Shade" shelter...........	52	76	85	80	90	103	100	107	88	87	69	69	[1] 107
Difference....	0	+2	0	0	+2	+3	+4	+2	+4	+5	+3	0	+2
1919.													
"Sun" shelter..	65	62	70	86	86	98	104	104	98	92	70	[a] 68	[2] 104
"Shade" shelter...........	66	61	70	85	84	95	100	101	96	91	69	[a] 67	[3] 101
Difference....	−1	+1	0	+1	+2	+3	+4	+3	+2	+1	+1	+1	+3

[1] Aug. 3. [2] July 31, Aug. 6. [3] Aug. 6.

TABLE 5.—*Minimum temperatures.*

	Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1918													
"Sun" shelter..	−18	−16	15	20	30	49	52	48	30	32	12	−3	[1] −18
"Shade" shelter	−17	−15	17	22	32	50	55	51	34	34	14	−1	[1] −17
Difference....	1	1	2	2	2	1	3	3	4	2	2	2	−1
1919.													
"Sun" shelter..	−19	0	1	27	38	46	54	50	42	24	5	−15	[2] −19
"Shade" shelter	−18	2	3	28	40	47	56	50	45	25	7	−13	[3] −18
Difference....	1	2	2	1	2	1	2	0	3	1	2	2	−1

[1] Jan. 12. [2] Jan. 2, 3. [3] Jan. 3.

TABLE 6.—*Greatest daily range of temperature.*

	Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1918.													
"Sun" shelter..	44	52	49	45	40	39	39	45	42	43	35	34	52
"Shade" shelter	41	48	47	44	37	33	30	40	44	35	38	34	48
Difference....	3	4	2	1	3	6	9	5	2	8	3	0	.....
1919.													
"Sun" shelter..	49	43	42	42	37	36	41	42	46	42	42	[a] 43	49
"Shade" shelter	49	42	39	39	34	31	35	36	40	37	40	[a] 41	49
Difference....	0	1	3	3	3	5	6	6	6	5	2	2	.....

TABLE 7.—*Greatest difference between daily readings on any day.*

	Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual mean difference.
1918.													
Maximum temperatures.....	3	4	5	3	4	4	4	6	5	7	3	3	4.2
Minimum temperatures.....	3	3	3	3	3	7	3	4	4	4	3	3	3.6
1919.													
Maximum temperatures.....	3	2	2	3	6	4	4	4	6	4	4	2	3.7
Minimum temperatures.....	3	4	2	2	3	2	3	4	5	3	2	4	3.1

NOTE.—In each instance given in this table the maximum was higher and the minimum lower in the "sun" shelter.

TABLE 8.—*Mean daily range of temperature.*

	Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1918.													
"Sun" shelter..	24.3	29.8	33.1	24.8	23.9	27.2	26.5	28.2	27.9	23.7	14.8	20.2	25.3
"Shade" shelter	22.8	28.3	31.2	22.8	21.3	23.2	22.4	23.8	22.9	19.6	12.9	18.4	22.5
Difference....	1.5	1.5	1.9	2.0	2.6	4.0	4.1	4.4	5.0	4.1	1.9	1.8	2.8
1919.													
"Sun" shelter..	26.2	22.0	24.1	21.6	23.0	22.4	27.7	27.3	27.9	25.2	28.6	19.1	24.6
"Shade" shelter	24.6	21.2	22.7	20.3	20.0	18.8	23.5	23.3	23.8	22.2	26.9	17.8	22.1
Difference....	1.6	0.8	1.4	1.3	3.0	3.6	4.2	4.0	4.1	3.0	1.7	1.3	2.5

THE STANDARD ATMOSPHERE.

(Discussion.)

With the advance of aeronautics and the science of artillery, engineers and specialists in these fields have come to require a specific knowledge of the varying states of the atmosphere from the ground to very great elevations. This has led to the introduction of a conventional term commonly known as *the standard atmosphere*, which pretends to specify the normal or average condition. As is well known, the "standard atmosphere" is never found; that is to say, at no time or place do "standard" or average conditions of all of the meteorological elements at all altitudes simultaneously occur. Nevertheless it is proper, and in certain fields (especially those of aviation and ordnance) it is necessary, to adopt so-called "standard" values, and it is desirable to have these represent as closely as possible true mean values in order that corrections due to departures from these means may be comparatively small in most cases. It would be advantageous, so far as accuracy is concerned, to use at least three sets of "standard" conditions—one for summer, one for winter, and a third for spring and autumn; but this would complicate the matter, so far as practical use is concerned, and the usual custom is, therefore, to adopt one set of values only and to use this set in computing a formula whose constants define the "standard atmosphere." *As already stated*, the values adopted for this purpose *should* be as nearly as possible true annual averages. These the meteorologist can furnish for many regions, principally for Europe and the United States, yet we find not infrequently "investigators" picking out a few observations here and there and spending (in effect *wasting*) much time and energy in computing formulæ for general application based thereon. An instance of this practice is to be found in a recent paper by M. Soreau,[1] in which he essays to establish "standard" free-air conditions. Unfortunately his results are based upon only *40* sounding balloon records, whereas some hundreds might have been used. Worse still, these 40 soundings are very poorly distributed as to season. There are 15 in the cold months January and February, 23 in the transitional months March to May, and only 2 in the one summer month of June, and even these 2 are in the early part of that month. It is not surprising, therefore, to find that the pressures at all heights above the surface are considerably below true annual averages.

Using his means M. Soreau evolves the following empiric equation:

$$Z = 5\ (3064 - 1.73\ P - 0.0011\ P^2) \log \frac{760}{P},$$

in which Z is the desired altitude and P the observed pressure. He states that this formula fits his mean values well, which is not surprising, since it is based upon them. It does not, however, fit any other values that have been published. Applied to those for Europe given by Dines,[2] the errors in determining Z are about 1.3 per cent; applied to those for the United States,[3] the errors are nearly 4 per cent. It is not to be expected, of course, that a single formula will apply to different, widely separated localities, but a formula for use in Europe should certainly be based upon representative European data. Otherwise, the conclusions mislead those not familiar with meteorological data. In a more recent note Rateau,[4] calls attention to discrepancies in Soreau's values and those given by Lapresle for Lindenberg, and expresses the hope that further information as to average free-air conditions may be obtained. As a matter of fact there is already sufficient information for this particular purpose, so far as Europe is concerned.

Naturally, the remainder of M. Soreau's paper, in which he discusses the relations between λ and μ (λ being the ratio of the specific gravity at Z altitude to that at the surface, and μ the corresponding ratio of pressures) is of little value, since it is based upon incomplete data.

Finally, a more acceptable discussion of the subject has been made by Prof. Pericle Gamba, who has employed a large number of observations in several countries, resulting in a reasonably close representation of the average conditions in the free air. Prof. Toussaint [5] has utilized Gamba's analysis of the meteorological data in the formulation of a proposed interallied agreement as to the law of decrease of temperature with increase of altitude.

[1] Lois expérimentales des variations de la pression barométrique et du poids spécifique de l'air avec l'altitude, par Rodolphe Soreau. *L'Aérophile*, Novembre 1-15, 1919, pp. 325-342. Also in briefer form in *Comptes Rendus*, December 1, 1919, pp. 1023-1025.

[2] Characteristics of the free atmosphere, W. H. Dines, F. R. S., *Geophysical Memoirs No. 13*, Meteorological Office, London, 1919, M. O. 220c. pp. 47-76.

[3] Kimball, H. H.: On the relations of atmospheric pressure, temperature, and density to altitude. MONTHLY WEATHER REVIEW, March, 1919, 47: 156-158.

Gregg, W. R.: Average free-air conditions as observed by means of kites at Drexel Aerological Station, Nebr., during the period Nov., 1915, to Dec., 1918, inclusive. MONTHLY WEATHER REVIEW, Jan., 1920, 48: 1-11.

[4] A. Rateau: Variations du poids spécifique de l'air avec l'altitude en atmosphére standard. *L'Aérophile*, Mars 1-15, 1920, pp. 72-73.

[5] Draft of interallied agreement on law adopted for the decrease of temperature with increase of altitude, Mar., 1920, Issued by Ministere de la Guerre, Aeronautique Militaire, Section Technique.

Toussaint proposes the adoption of a "law" of linear decrease of temperature with altitude, starting at a temperature of 15° C. at sea level and attaining −50° C. at an altitude of 10,000 meters. This "law" is expressed by the formula $t = 15 - 0.0065\ Z$, in which t = temperature in °C. and Z = altitude in meters.

Using this formula for computing the "standard" temperature for various heights, and assuming further that the atmosphere is dry and that gravity remains constant at all levels, the author quickly determines the appropriate values of pressure and density. The results are given, in abridged form, in the following table:

Altitude above mean sea level.	Pressure.	Temperature.	Density.
m.	*mm.*	°C.	*kg./cu.m.*
0	760	15	1.225
500	714.2	13	1.165
1,000	673.4	9	1.112
1,500	634	6	1.060
2,000	596.2	2	1.008
2,500	560	− 1	0.957
3,000	525.7	− 5	0.907
3,500	493	− 8	0.865
4,000	462.2	−11	0.820
4,500	432.2	−14	0.778
5,000	405	−18	0.735
6,000	353.8	−24	0.660
7,000	307.8	−31	0.588
8,000	266.9	−37	0.525
9,000	230.4	−44	0.467
10,000	198.2	−50	0.413

Although the adopted rate of temperature decrease is arbitrary, the resulting values nevertheless agree quite well with annual means as published by various investigators for Europe and the United States. (*Cf.* references in footnotes 2 and 3.) Prof. Toussaint remarks:

> It has been found preferable to take a linear law rather than to seek an equation approximate to Prof. Gamba's curve, for the following reason:
>
> In order to define the standard atmosphere, what is needed is not an exact representation of that curve, but merely a law that can be conveniently applied and which is sufficiently in concordance with the means adhered to. By this method, corrections due to temperature will be as small as possible in calculations of airplane performances, and will be easy to calculate. The proposed law seems likely to realize such conditions.
>
> The deviation is of some slight importance only at altitudes below 1,000 meters, which altitudes are of little interest in aerial navigation. The simplicity of the formula largely compensates this inconvenience.
>
> It must be remarked, however, that since the isothermal layers seem to commence, in European regions, at an altitude of about 11,000 meters, it would be dangerous to extrapolate above that altitude.
>
> When it becomes an ordinary occurrence for airplanes to attain that altitude, it will be necessary to modify the law, but it suffices for the machines now in use.

It should be further remarked that the proposal is improperly referred to as a "law." A law is supposed to define something that is exact, within reasonable limits, whereas the actual conditions at different times and places will differ widely from this or any other assumed rate of decrease. "Standard atmosphere" is probably the best expression. It is to be hoped, though, that not even that term will be adopted, until all, or at any rate most, countries have agreed to use the same values.—*W. R. Gregg.*

INTERVALS BETWEEN BEGINNING OF RAINFALL IN WEST AND CENTRAL FRANCE.

A letter received from Albert Jagot, of Le Mans, France, gives an account of some interesting studies on the intervals between rainfall at Nantes and Le Mans and between Brest and Le Mans. By grouping low-pressure locations and high-pressure locations he has